

## CLAIMS

What is claimed is:

1 1. A method performed by a first computer node for selecting a leader node to provide  
2 service to a plurality of other nodes in a multicast group, wherein each of the nodes  
3 communicates using multicast, broadcast or anycast messages, the method comprising the  
4 computer-implemented steps of:  
5 issuing a first election call message;  
6 receiving candidacy announcement messages from one or more leader candidate  
7 nodes in a specified time period;  
8 selecting a victor from among all leader candidate nodes from which candidacy  
9 announcement messages are received;  
10 receiving one or more victor announcement messages from one or more leader victor  
11 nodes for a second specified time period;  
12 resolving zero or more collisions among the victor announcement messages to result  
13 in selecting the leader node.

1 2. A method as recited in Claim 1, wherein the leader node is a key server that provides  
2 keys for use in encrypting multicast group messages.

1 3. A method as recited in Claim 1, wherein the leader node is a GDOI key server that  
2 provides keys to nodes according to Group Domain of Interpretation.

1 4. A method as recited in Claim 1, further comprising:  
2 performing a coin toss operation that results in either a first result or a second result;  
3 and  
4 sending a candidacy announcement message in response to the first result occurring,  
5 or awaiting the candidacy announcement messages from the one or more  
6 leader candidate nodes in response to the second result occurring.

- 1 5. A method as recited in Claim 1, wherein the step of selecting a victor further  
2 comprises the steps of:  
3 determining whether the first computer node is the winner; and  
4 sending a victor announcement message in response to determining that the first  
5 computer node is the winner.
- 1 6. A method as recited in Claim 1, further comprising the step of ignoring any election  
2 call messages while awaiting receipt of the one or more candidacy announcement messages.
- 1 7. A method as recited in Claim 1, wherein selecting a victor comprises selecting one of  
2 the leader candidate nodes having a highest network address.
- 1 8. A method as recited in Claim 1, wherein resolving any collisions comprises:  
2 determining that two or more announcement messages have been received; and  
3 issuing a second election call message.
- 1 9. A method as recited in Claim 1, wherein the election call message, candidacy  
2 announcement messages, and victor announcement messages are multicast, broadcast or  
3 anycast messages.
- 1 10. A method as recited in Claim 1, further comprising the steps of:  
2 receiving, in the first election call message, first identity information specifying a  
3 second node that sent the first election call message;  
4 pushing the identity information onto a stack;  
5 receiving a second election call message that includes second identity information  
6 specifying a third node that sent the second election call message; and  
7 ignoring the second election call message when the second identity information is  
8 found in the stack.

1 11. A method as recited in Claim 1, wherein each of the messages comprises a packet  
2 type value, sender sequence number value, sender identity value, and a digital signature of a  
3 node that sent the message.

1 12. A method as recited in Claim 1, further comprising digitally signing each of the  
2 messages.

1 13. A method as recited in Claim 1, further comprising the steps of:  
2 creating a sequence number for each message that is sent;  
3 digitally signing each message before sending the message; and  
4 incrementing the sequence number.

1 14. A method as recited in Claim 1, wherein the step of issuing the first election call  
2 message is performed only after failing to receive a reply to a key server discovery message  
3 that is sent by the first node upon newly joining a multicast group.

1 15. A method as recited in Claim 1, wherein the first node is a member of an ad hoc  
2 multicast group.

1 16. A method performed by a first computer node for selecting a Group Domain of  
2 Interpretation (GDOI) key server to provide key service to a plurality of client nodes in a  
3 multicast group, the method comprising the computer-implemented steps of:  
4 issuing a first election call message;  
5 receiving candidacy announcement messages from one or more leader candidates in a  
6 specified time period;  
7 selecting a winner from among all leader candidates from which candidacy  
8 announcement messages are received;  
9 receiving one or more victor announcement messages from one or more leader victor  
10 nodes for a second specified time period;

11 resolving zero or more collisions among the victor announcement messages to result  
12 in selecting the leader node;  
13 wherein the election call message, candidacy announcement messages, and victor  
14 announcement messages are multicast, broadcast or anycast messages.

1 17. A method as recited in Claim 16, further comprising the steps of:  
2 receiving, in the first election call message, first identity information, specifying a  
3 second node that sent the first election call message;  
4 pushing the identity information onto a stack;  
5 receiving a second election call message that includes second identity information  
6 specifying a third node that sent the second election call message; and  
7 ignoring the second election call message when the second identity information is  
8 found in the stack.

1 18. A method as recited in Claim 16, wherein the step of issuing the first election call  
2 message is performed only after failing to receive a reply to a key server discovery message  
3 that is sent by the first node upon newly joining a multicast group.

1 19. A method as recited in Claim 16, further comprising:  
2 performing a coin toss operation that results in either a first result or a second result;  
3 and  
4 sending a candidacy announcement message in response to the first result occurring,  
5 or awaiting the candidacy announcement messages from the one or more  
6 leader candidates in response to the second result occurring.

1 20. A method as recited in Claim 16, wherein the step of selecting a winner further  
2 comprises the steps of:  
3 determining whether the first computer node is the winner; and  
4 sending a victor announcement message in response to determining that the first  
5 computer node is the winner.

1 21. A method as recited in Claim 16, further comprising the step of ignoring any election  
2 call messages while awaiting receipt of the one or more candidacy announcement messages.

1 22. A method as recited in Claim 16, wherein selecting a winner comprises selecting one  
2 of the leader candidates having a highest network address.

1 23. A method as recited in Claim 16, wherein resolving any collisions comprises:  
2 determining that two or more announcement messages have been received; and  
3 issuing a second election call message.

1 24. A method as recited in Claim 16, wherein each of the messages comprises a packet  
2 type value, sender sequence number value, sender identity value, and a digital signature of a  
3 node that sent the message.

1 25. A method as recited in Claim 1, further comprising the steps of:  
2 creating a sequence number for each message that is sent;  
3 digitally signing each message before sending the message; and  
4 incrementing the sequence number.

1 26. A method as recited in Claim 1, wherein the first node is a member of an ad hoc  
2 multicast group.

1 27. A computer-readable medium carrying one or more sequences of instructions for a  
2 first computer node for selecting a leader node to provide service to a plurality of other nodes  
3 in a multicast group, wherein each of the nodes communicates using multicast, broadcast or  
4 anycast messages, which instructions, when executed by one or more processors, cause the  
5 one or more processors to carry out the steps of:  
6 issuing a first election call message;

7 receiving candidacy announcement messages from one or more leader candidate  
8 nodes in a specified time period;  
9 selecting a victor from among all leader candidate nodes from which candidacy  
10 announcement messages are received;  
11 receiving one or more victor announcement messages from one or more leader victor  
12 nodes for a second specified time period;  
13 resolving zero or more collisions among the victor announcement messages to result  
14 in selecting the leader node.

1 28. A computer-readable medium as recited in Claim 27, wherein the leader node is a key  
2 server that provides keys for use in encrypting multicast group messages.

1 29. A computer-readable medium as recited in Claim 27, wherein the leader node is a  
2 GDOI key server that provides keys to nodes according to Group Domain of Interpretation.

1 30. A computer-readable medium as recited in Claim 27, further comprising instructions  
2 for:  
3 performing a coin toss operation that results in either a first result or a second result;  
4 and  
5 sending a candidacy announcement message in response to the first result occurring,  
6 or awaiting the candidacy announcement messages from the one or more  
7 leader candidate nodes in response to the second result occurring.

1 31. A computer-readable medium as recited in Claim 27, wherein the instructions for the  
2 step of selecting a victor further comprise instructions for the steps of:  
3 determining whether the first computer node is the winner; and  
4 sending a victor announcement message in response to determining that the first  
5 computer node is the winner.

1 32. A computer-readable medium as recited in Claim 27, further comprising instructions  
2 for the step of ignoring any election call messages while awaiting receipt of the one or more  
3 candidacy announcement messages.

1 33. A computer-readable medium as recited in Claim 27, wherein selecting a victor  
2 comprises selecting one of the leader candidate nodes having a highest network address.

1 34. A computer-readable medium as recited in Claim 27, wherein resolving any collisions  
2 comprises:  
3 determining that two or more announcement messages have been received; and  
4 issuing a second election call message.

1 35. A computer-readable medium as recited in Claim 27, wherein the election call  
2 message, candidacy announcement messages, and victor announcement messages are  
3 multicast, broadcast or anycast messages.

1 36. A computer-readable medium as recited in Claim 27, further comprising instructions  
2 for the steps of:  
3 receiving, in the first election call message, first identity information specifying a  
4 second node that sent the first election call message;  
5 pushing the identity information onto a stack;  
6 receiving a second election call message that includes second identity information  
7 specifying a third node that sent the second election call message; and  
8 ignoring the second election call message when the second identity information is  
9 found in the stack.

1 37. A computer-readable medium as recited in Claim 27, wherein each of the messages  
2 comprises a packet type value, sender sequence number value, sender identity value, and a  
3 digital signature of a node that sent the message.

1 38. A computer-readable medium as recited in Claim 27, further comprising digitally  
2 signing each of the messages.

1 39. A computer-readable medium as recited in Claim 27, further comprising instructions  
2 for the steps of:  
3 creating a sequence number for each message that is sent;  
4 digitally signing each message before sending the message; and  
5 incrementing the sequence number.

1 40. A computer-readable medium as recited in Claim 27, wherein the step of issuing the  
2 first election call message is performed only after failing to receive a reply to a key server  
3 discovery message that is sent by the first node upon newly joining a multicast group.

1 41. A computer-readable medium as recited in Claim 27, wherein the first node is a  
2 member of an ad hoc multicast group.

1 42. An apparatus for a first computer node for selecting a leader node to provide service  
2 to a plurality of other nodes in a multicast group, wherein each of the nodes communicates  
3 using multicast, broadcast or anycast messages, comprising:  
4 means for issuing a first election call message;  
5 means for receiving candidacy announcement messages from one or more leader  
6 candidate nodes in a specified time period;  
7 means for selecting a victor from among all leader candidate nodes from which  
8 candidacy announcement messages are received;  
9 means for receiving one or more victor announcement messages from one or more  
10 leader victor nodes for a second specified time period;  
11 means for resolving zero or more collisions among the victor announcement  
12 messages to result in selecting the leader node.



1 43. An apparatus as recited in Claim 42, wherein the leader node is a key server that  
2 provides keys for use in encrypting multicast group messages.

1 44. An apparatus as recited in Claim 42, wherein the leader node is a GDOI key server  
2 that provides keys to nodes according to Group Domain of Interpretation.

1 45. An apparatus as recited in Claim 42, further comprising:  
2 means for performing a coin toss operation that results in either a first result or a  
3 second result; and  
4 means for sending a candidacy announcement message in response to the first result  
5 occurring, or awaiting the candidacy announcement messages from the one or  
6 more leader candidate nodes in response to the second result occurring.

1 46. An apparatus as recited in Claim 42, wherein the means for selecting a victor further  
2 comprises:  
3 means for determining whether the first computer node is the winner; and  
4 means for sending a victor announcement message in response to determining that the  
5 first computer node is the winner.

1 47. An apparatus as recited in Claim 42, further comprising means for ignoring any  
2 election call messages while awaiting receipt of the one or more candidacy announcement  
3 messages.

1 48. An apparatus as recited in Claim 42, wherein the means for selecting a victor  
2 comprises means for selecting one of the leader candidate nodes having a highest network  
3 address.

1 49. An apparatus as recited in Claim 42, wherein the means for resolving any collisions  
2 comprises:  
3 means for determining that two or more announcement messages have been received;  
4 and  
5 means for issuing a second election call message.

1 50. An apparatus as recited in Claim 42, wherein the election call message, candidacy  
2 announcement messages, and victor announcement messages are multicast, broadcast or  
3 anycast messages.

1 51. An apparatus as recited in Claim 42, further comprising the steps of:  
2 means for receiving, in the first election call message, first identity information  
3 specifying a second node that sent the first election call message;  
4 means for pushing the identity information onto a stack;  
5 means for receiving a second election call message that includes second identity  
6 information specifying a third node that sent the second election call message;  
7 and  
8 means for ignoring the second election call message when the second identity  
9 information is found in the stack.

1 52. An apparatus as recited in Claim 42, wherein each of the messages comprises a  
2 packet type value, sender sequence number value, sender identity value, and a digital  
3 signature of a node that sent the message.

1 53. An apparatus as recited in Claim 42, further comprising means for digitally signing  
2 each of the messages.

1 54. An apparatus as recited in Claim 42, further comprising:  
2 means for creating a sequence number for each message that is sent;

3 means for digitally signing each message before sending the message; and  
4 means for incrementing the sequence number.

1 55. An apparatus as recited in Claim 42, further comprising means for issuing the first  
2 election call message only after failing to receive a reply to a key server discovery message  
3 that is sent by the first node upon newly joining a multicast group.

1 56. An apparatus as recited in Claim 42, wherein the first node is a member of an ad hoc  
2 multicast group.

1 57. An apparatus for a first computer node for selecting a leader node to provide service  
2 to a plurality of other nodes in a multicast group, wherein each of the nodes communicates  
3 using multicast, broadcast or anycast messages, comprising:  
4 a network interface that is coupled to the data network for receiving one or more packet  
5 flows therefrom;  
6 a processor;  
7 one or more stored sequences of instructions which, when executed by the processor, cause  
8 the processor to carry out the steps of:  
9 issuing a first election call message;  
10 receiving candidacy announcement messages from one or more leader candidate  
11 nodes in a specified time period;  
12 selecting a victor from among all leader candidate nodes from which candidacy  
13 announcement messages are received;  
14 receiving one or more victor announcement messages from one or more leader victor  
15 nodes for a second specified time period;  
16 resolving zero or more collisions among the victor announcement messages to result  
17 in selecting the leader node.

1 58. An apparatus as recited in Claim 57, wherein the leader node is a key server that  
2 provides keys for use in encrypting multicast group messages.

1 59. An apparatus as recited in Claim 57, wherein the leader node is a GDOI key server  
2 that provides keys to nodes according to Group Domain of Interpretation.

1 60. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for:

3 performing a coin toss operation that results in either a first result or a second result;

4 and

5 sending a candidacy announcement message in response to the first result occurring,

6 or awaiting the candidacy announcement messages from the one or more

7 leader candidate nodes in response to the second result occurring.

1 61. An apparatus as recited in Claim 57, wherein the step of selecting a victor further  
2 comprises the steps of:

3 determining whether the first computer node is the winner; and

4 sending a victor announcement message in response to determining that the first

5 computer node is the winner.

1 62. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for ignoring any election call messages while awaiting receipt of the one or more  
3 candidacy announcement messages.

1 63. An apparatus as recited in Claim 57, wherein selecting a victor comprises selecting  
2 one of the leader candidate nodes having a highest network address.

1 64. An apparatus as recited in Claim 57, wherein resolving any collisions comprises:  
2 determining that two or more announcement messages have been received; and  
3 issuing a second election call message.

1 65. An apparatus as recited in Claim 57, wherein the election call message, candidacy  
2 announcement messages, and victor announcement messages are multicast, broadcast or  
3 anycast messages.

1 66. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for:  
3 receiving, in the first election call message, first identity information specifying a  
4 second node that sent the first election call message;  
5 pushing the identity information onto a stack;  
6 receiving a second election call message that includes second identity information  
7 specifying a third node that sent the second election call message; and  
8 ignoring the second election call message when the second identity information is  
9 found in the stack.

1 67. An apparatus as recited in Claim 57, wherein each of the messages comprises a  
2 packet type value, sender sequence number value, sender identity value, and a digital  
3 signature of a node that sent the message.

1 68. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for digitally signing each of the messages.

1 69. An apparatus as recited in Claim 57, the sequences of instructions further comprising  
2 instructions for the steps of:  
3 creating a sequence number for each message that is sent;  
4 digitally signing each message before sending the message; and  
5 incrementing the sequence number.

1 70. An apparatus as recited in Claim 57, wherein the sequences of instructions for issuing  
2 the first election call message are performed only after failing to receive a reply to a key  
3 server discovery message that is sent by the first node upon newly joining a multicast group.

1 71. An apparatus as recited in Claim 57, wherein the first node is a member of an ad hoc  
2 multicast group.